

Operating Systems
Professor Ward
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Latency and Datarate

Work in pairs if possible. Show your work.

a) How long does it take to send a message from Paris to Dunkerque? Compute the time from the moment the general in Paris hands the message to the telegrapher in Paris until the moment when the telegrapher in Dunkerque, hands the complete message to his commander. Assume that

- the message is 50 words long,
- the average word length is 7 letters
- there is a unique configuration of the semaphore vanes for each word in the codebook
- the codebook contains 700 words,
- there are 20 towers between Paris and Dunkerque,
- it takes 20 seconds to encode each word as a configuration
- it takes 20 seconds to decode each configuration to a word
- each telegrapher takes 3 seconds to view and confirm the configuration the neighboring tower is showing him
- each telegrapher takes 15 seconds to set the configuration so the next tower can see it
- the speed of light is infinite (the propagation delay is zero)
- it's a sunny day

Document any additional assumptions if you feel they are required.

→ There will 20 towers, including the first tower, the last tower, and the middle tower.

The first tower: $(15s \text{ (set the configuration)} + 20s \text{ (encoding)}) * 50 \text{ (number of words)}$

The last tower: $(3s \text{ (view and confirm the configuration)} + 20s \text{ (decoding)}) * 50 \text{ (number of words)}$

The middle towers: $(3s \text{ (view and confirm the configuration)} + 15s \text{ (set the configuration)}) * 50 \text{ (number of words)} * 18 \text{ (number of towers)}$

Thus: $1 * (15 + 20) * 50 + 1 * (3 + 20) * 50 + 18 * (3 + 15) * 50 =$

$35 * 50 + 23 * 50 + 18 * 18 * 50 = 1750 + 1150 + 16200 = 19100s$

$19100s / 60 = 318.33 \text{ min}$

$318.33 / 60 = 5.3 \text{ hrs}$

Assumption:

Decode and encode will only take place on the first and last tower due to end-to-end encryption system.

b) Now imagine that the protocol is revised so that each telegrapher waits to confirm transmission of the message to the next tower. That is, he does not start to change his vane configuration until he sees that the next tower has replicated it correctly. What now is the time required to send the message?

→ There will 20 towers, including the first tower, the last tower, and the middle tower.

This time, the tower will for the next tower to configure which takes 15 seconds.

The first tower: (15s (set the configuration) + 20s (encoding) + 15s (waiting time for next tower))*50(number of words)

The last tower: (3s (view and confirm the configuration) + 20s(decoding)) * 50(number of words)

The middle towers: (3s (view and confirm the configuration) + 15s (set the configuration) + 15s(waiting time for next tower))*50(number of words)*18(number of towers))

Thus: $1*(15+20+15)*50+1*(3+20)*50+18*(3+15+15)*50 =$

$50*50+23*50+18*33*50=2500+1150+29700 = 33350s$

$33350s/60 = 555.833 \text{ min}$

$555.833/60 = 9.26 \text{ hrs}$

c) What is the maximum datarate, in bits per second, using the initial scheme?

→

letters per second: $7*50/19100 = 0.18$

words per second: $50/19100 = 0.0026$

d) What is the maximum datarate using the revised protocol?

→

letters per second: $7*50/33350 = 0.01$

words per second: $50/33350 = 0.0015$

e) Suppose you would like to urgently deliver 40 terabytes of data from Boston to Los Angeles. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain. (question from Kurose and Ross)

40 terabytes = $40 * 10^{12} * 8 \text{ bits}$

$40*10^{12}*8\text{bits} / 10^6 = 40*10^6*8 \text{ mb}$

$40*10^6*8/100 = 3200000s$

$3200000 / 60 = 53333.333 \text{ min}$

$53333.333 / 60 = 888.888 \text{ hrs}$

$888.888 / 24 = 37.04$ days

By using the available 100Mbps dedicated link for data transfer will take 37 days, more than a month. With FedEx overnight delivery is within a day which is a lot faster. If it is going to be urgent or be used within a month (37 days), definitely FedEx is the best option, however, if it is something that it can be doing the transfer in the background, using the link might not be a problem. Since the question is “urgently”, in this case, FedEx is the way to go.